

CALIFORNIA AGRICULTURAL EXPERIMENT STATION

IRRIGATION EXPERIMENTS

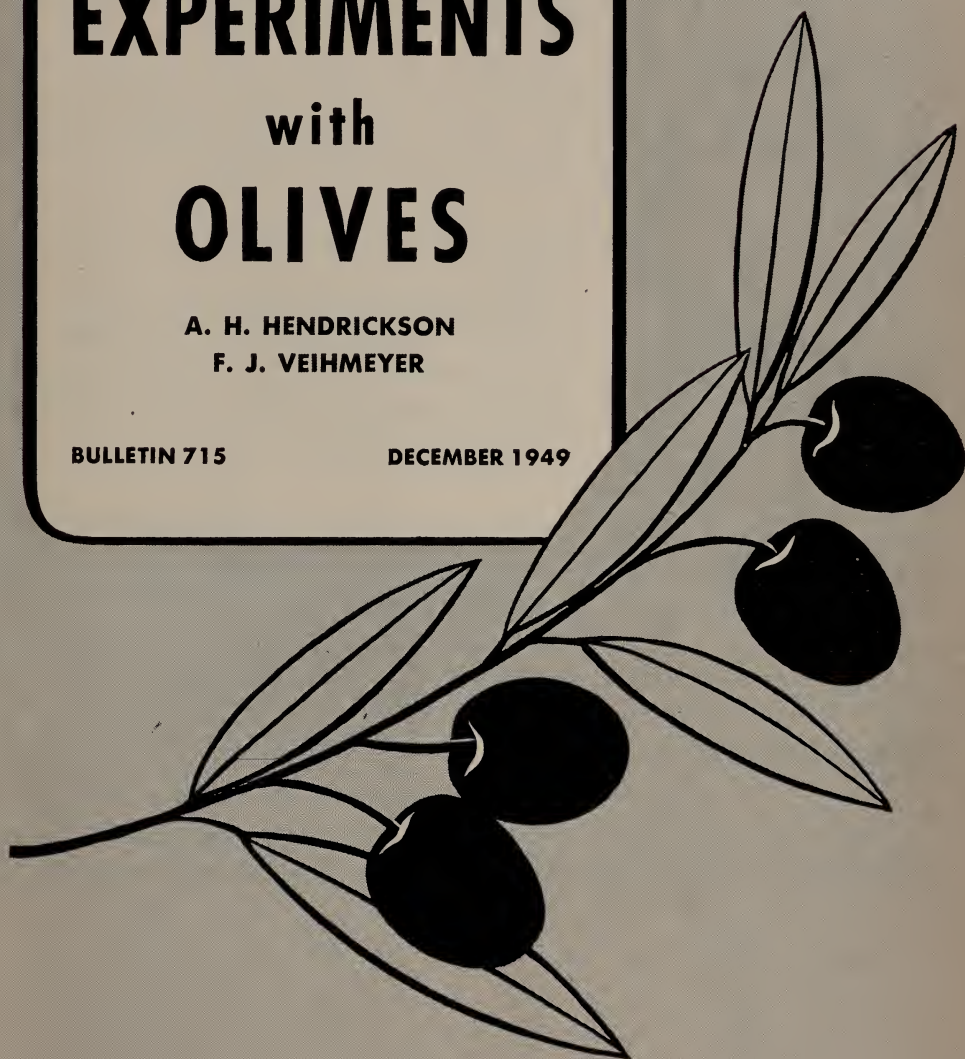
with

OLIVES

A. H. HENDRICKSON
F. J. VEIHMAYER

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"The olive does not use much water" is a misconception.

Olives use as much water as other trees—possibly more.



This bulletin describes irrigation experiments with olives conducted by the University of California during the past three years. These experiments have shown that—

1. GROWTH of olive fruits is affected by the lack of readily available soil moisture, particularly in the top three feet of soil.
2. Olives on Hanford sandy loam, or on soils having about the same characteristics, should be **IRRI-GATED** once every four weeks during the summer, provided the soil is wetted to six feet each time. Irrigation on shallow soils should be lighter and more frequent.
3. Olives should also have **EARLIER SPRING** and **LATER FALL** irrigations than are necessary with deciduous fruits.

The Authors:

A. H. Hendrickson is Pomologist in the Experiment Station, Davis.

F. J. Veihmeyer is Professor of Irrigation and Irrigation Engineer in the Experiment Station, Davis.

Olives have long been thought to be drouth-resistant. They have been planted for centuries in areas of light rainfall such as those around the Mediterranean Sea. In more recent times they have been planted in similar areas in Arizona and California. Olives in California were first planted in unirrigated sections, as they had been planted in the old world. The growers did not understand that planting of olives in the Mediterranean countries without provision for irrigation had been a matter of necessity rather than choice. Olives had been planted in regions of inadequate rainfall or irrigation because they were one of the crops that produced fairly well without irrigation. In parts of North Africa olives are planted with wide spacings between the trees, in order to make the best use of the rather scanty rainfall.

Early studies on the drouth resistance of olives were chiefly concerned with general observations on the appearance and bearing habits of the tree, the characteristics of the soil regarding its origin, texture, and depth, and the climatic conditions of the region. There is no evidence that any effort was made to study the soil-moisture conditions existing in olive orchards during the year. These studies seem to have reached the general conclusion that the olive uses but little moisture.

The olive tree appears to be well adapted to withstanding drouth. The leaves are small and leathery, and have a comparatively thick cuticle on the

upper surface that tends to restrict the loss of water. On the undersurface the leaves are protected by a mass of peltate hairs. The stomata, while numerous on the undersurface, are sunken, and have small openings. The leaves are apparently uninjured by long periods of hot weather and dry soil conditions.

Nevertheless, it is a misconception that the olive does not use much water. This idea probably arose from the fact that it does fairly well under dry soil conditions, and does not seem to be injured when other trees may die. Irrigation experiments with olive trees show that they use as much water as other trees, and possibly more. Growers have found that, where irrigation is possible, the trees may be kept vigorous and productive by the application of water at suitable intervals.

Irrigation experiments with olives have been carried out by the University of California in southern Tulare County during the past three years. Two plots of 18 trees each were selected for the experiment. The trees, of the Manzanillo variety, were about 25 years old and planted in 30 foot squares. They were vigorous, fairly uniform, and had been producing large crops for a number of years.

The soil was classed as a Hanford sandy loam, and was fairly uniform to a depth of six feet. Characteristics concerned with the water-holding properties of this soil are given in Table 1. The moisture equivalents represent the upper

TABLE 1—Moisture equivalents, permanent wilting percentages, and apparent specific gravities of the Hanford sandy loam used in the experiments with olives.

Depth	Moisture equivalent	Permanent wilting percentage	Apparent specific gravity
0 to 1 ft.	12.0	4.5	1.65
1 to 2 ft.	10.7	4.0	1.50
2 to 3 ft.	9.1	3.4	1.55
3 to 4 ft.	7.4	3.1	1.57
4 to 5 ft.	6.5	3.3	1.55
5 to 6 ft.	7.2	3.6	1.58

limits of the readily available moisture; the permanent wilting percentages, the lower limits. The apparent specific gravities are used in calculating the amount of water that may be held in a soil.

The cultural practice followed was to disk or cultivate in the spring; irrigate as often as necessary during the summer, and smooth the soil surface just before harvesting the crop.

The Experiment

The general procedure during the three years was, first, to treat both plots alike until after the fruit had set; then to stop irrigating one of them, allowing its soil moisture to drop to the permanent wilting percentage, and letting it remain dry for a considerable time.

Soil samples were taken from both plots at biweekly intervals.

As soon as the fruit was large enough to measure, 100 fruits (25 on each of four trees) were measured and tagged. Fruit measurements were repeated each time the soil samples were taken. At the end of the experiment, samples of fruit were taken for weighing.

Inasmuch as the experiment produced similar results in each of the three years, only the 1948 results are described here in detail.

The irrigation procedure in 1948 was as follows:

1. Both plots were irrigated on March 10 and June 2.
2. The dry (east) plot was not irrigated after June 2, and the trees were subjected to a prolonged period without readily available moisture in the top six feet of soil.
3. The irrigated (west) plot was watered additionally on July 22, August 16 and September 15. All the later summer irrigations on the wet plot were light and did not materially increase the moisture supply below the third foot.

The Results

Soil-moisture conditions

The results of the 1948 soil sampling are shown in Figure 1.

Both plots until July 22: The slow steady withdrawal of soil moisture during the early part of the season in both plots is indicated by the downward slope of the curves between March 16 and May 26. The irregularities in the curve for the top foot were caused by spring rains which added some moisture to the first foot of soil. The readily available moisture was almost exhausted in the top foot about the last of May. Part of this loss was due to transpiration by the trees, and the rest by direct evaporation from the surface of the soil. There was still readily available moisture below the first foot when both plots were irrigated on June 2. The peaks in the curve when the next soil samples were taken a week later, on June 9, show that water had penetrated at least six feet. The downward slope, following June 9, shows fairly rapid extraction of water in the upper layers, with a somewhat slower extraction from the lower depths. The readily available moisture was exhausted for the second time from the first foot late in June.

East (dry) plot from July 22: The permanent wilting percentage was reached in the east plot late in July in the second foot, and about August 4 in the third foot. The readily available moisture was exhausted in the fourth, fifth, and sixth foot depths about the middle of August. The unirrigated plot was without readily available moisture in the various depths from the dates given above until after the crop was picked on October 13. In other words the roots of the trees in the unirrigated plot were in dry soil in the top foot about 16 weeks; in the second foot about 11 weeks; in the third foot about 10 weeks; and in the fourth, fifth, and sixth foot depths about 8 weeks.

West (irrigated) plot from July 22: The soil-moisture conditions were consider-

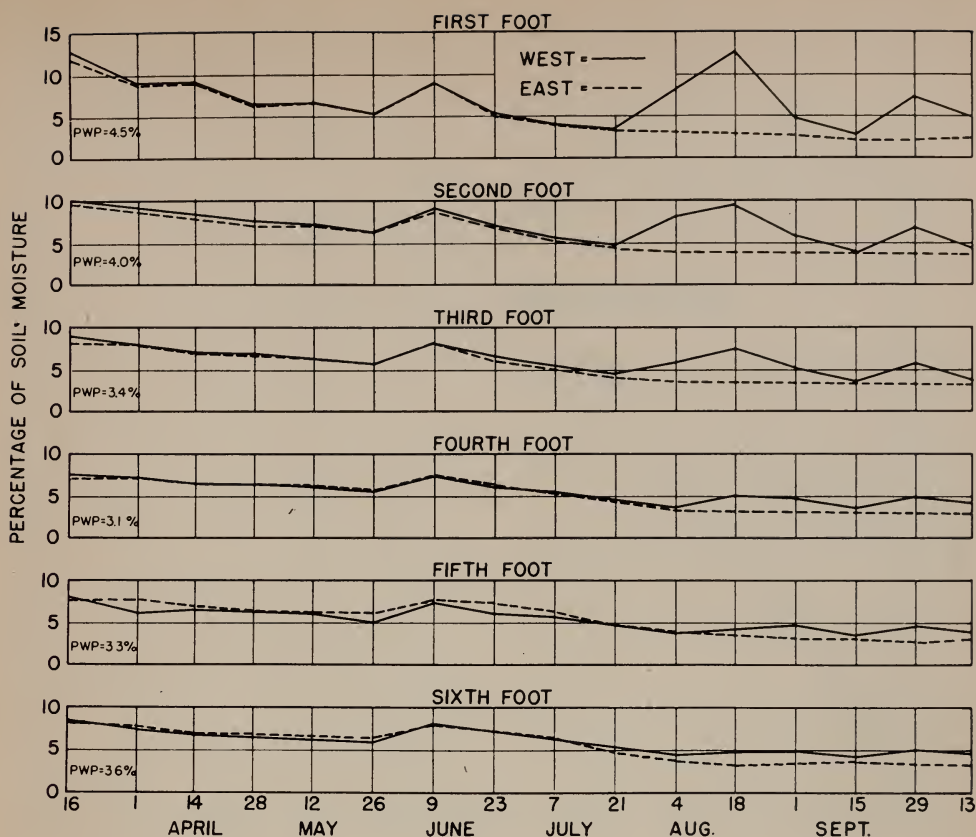


Fig. 1. Soil-moisture record of the Manzanillo olive orchard on Hanford sandy loam soil.
West plot irrigated, east plot not irrigated after June 2.

ably different in the irrigated plot, in spite of the fact that three irrigations (July 22, August 16 and September 15) did not increase the moisture supply very much in the lower depths. (Note: the soil moisture contents of the closely spaced irrigations on July 22 and August 16 are shown as a single peak because a set of samples was not obtained just prior to the second application of water on August 16.) The growth of fruits, reported below, was affected by the moisture added to the top three feet.

The readily available soil moisture in the top three feet was exhausted rapidly after the irrigation of August 16 (on the graph, during the period following August 18). The permanent wilting percentage in the second and third foot

depths was reached again early in September. The readily available moisture in the fourth, fifth, and sixth foot depths had been exhausted about the middle of August (as in the dry plot). The final irrigation on September 15 replenished the supply in the top two feet and added water in some places to a depth of six feet, but the average amount added to the lower depths was rather small.

Comparative growth of fruit

The average growth of the fruit in the experimental plot is given in Figure 2.

100 fruits from each of the two plots were measured. The first measurements were made on June 23. On that date, the average size of fruit in the irrigated plot was 0.93 centimeter, and of those in the

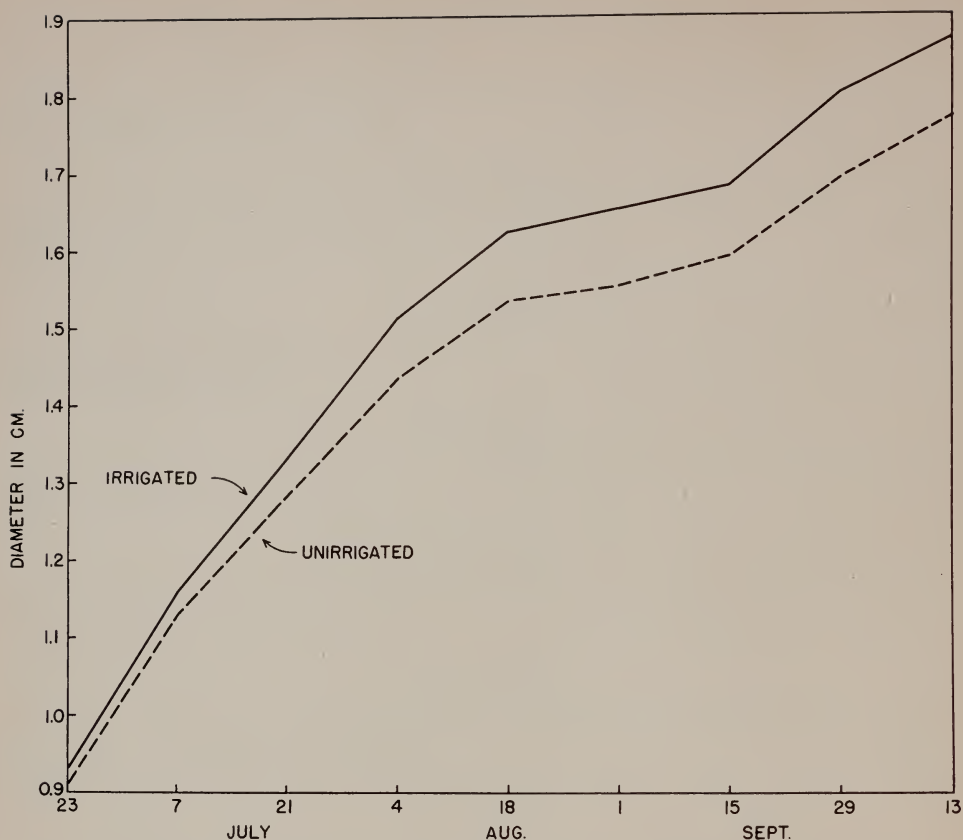


Fig. 2. Average diameter measurements of Manzanillo olives during the growing season.

unirrigated plot 0.91 centimeter in diameter. The fruit in both plots grew at about the same rate until July 21. By August 4, when the readily available moisture was exhausted in the top three feet in the east (dry) plot, the irrigated fruit was significantly larger than the unirrigated fruit, and remained so until harvest.

When picked on October 13, the fruit in the west (irrigated) plot averaged 1.87 centimeters in diameter, while that in the east (dry) plot averaged 1.77. This seemingly small difference in size was sufficient to put the irrigated fruits into a larger grade size than the others. A random sample of fruit from each plot showed the average weight of olives from the irrigated trees to be 4.4 grams; from the dry, 3.4 grams. In spite of the long period of

exhaustion of readily available moisture in the east (dry) plot, no shriveling was noticed on the Manzanillo olives in the experiment.

Observations

The soil-moisture record shows that the unirrigated plot was without readily available moisture for periods varying from 8 to 16 weeks according to depth. The irrigated plot had readily available moisture, at least in the second and third foot depths, except for the comparatively brief periods mentioned. The record for the irrigated plot is valuable in that it illustrates the kind of soil-moisture conditions that probably prevail in many orchards, during the growing season. It

also illustrates how difficult it is to wet even a pervious soil to the full depth in which most of the roots are located. The soil in which these experiments were conducted holds five or six inches of water in the top six feet, and when dry requires as many inches to bring the supply back to the average field capacity. In some of the irrigations, however, only about three inches had been applied on the average.

Also interesting is the length of time water was readily available in both plots in the period following the June 2 irrigation. The curves show that there was readily available moisture for about three weeks in the top foot, about five weeks in the second and third foot, and for a longer period in the lower depths. It appears that a safe interval between irrigations on soils having about the same characteristics as the soil used in these experiments would be about **four weeks**, during the summer, provided the soil was wetted to a depth of six feet each time. In shallow soils the irrigations should be more frequent, with less water applied at each irrigation than is indicated from the experiments conducted on a deep soil. The olive uses between 24 and 30 acre-inches per acre of water during the grow-

ing season. Additional water will be necessary during the fall or winter—depending on climatic conditions—because the olive undoubtedly uses some water on warm clear days during the winter.

The use of a soil tube or auger may be helpful in deciding whether irrigation is needed.

Conclusions

1. The olive responds to a lack of readily available soil moisture just as other trees do.
2. Growth of olive fruits is affected by the lack of readily available soil moisture. Since large olives for pickling bring greater returns than small ones, it is important to irrigate frequently enough to prevent slowing down in growth due to lack of readily available soil moisture.
3. In addition to the summer irrigations, olives should have **earlier spring and later fall irrigations** than are necessary with deciduous fruits.
4. The variety used in the experiment—the Manzanillo—does not shrivel even when subjected to a long period of dry soil conditions.

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